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Pattern and Color in the Cichlid Fish, *Aequidens tetramerus.*[1]

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(Plate I).

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As a preliminary to the study of some Venezuelan fishes and especially their reactions to the dry and the wet seasons, I wish to present a comparison of the pattern and color descriptions of one species of cichlid taken from ichthyological literature, with the twenty-four hour variation of a single individual of the same species.

This fish is *Aequidens tetramerus*, originally described by Heckel (*Acara tetramerus*, Heckel, 1841, *Ann. Wiener Mus.*, II, 341). It has a wide distribution, from Venezuela and the Guianas, on throughout the Amazonian drainage system to eastern Ecuador, and south to Brazil and Paraguay.

Eight Descriptions Selected from Literature.

"Color in alcohol, at the present time: in general chocolate brown; toward the back of the head almost black, lighter toward the breast; each scale with a light spot at its base. A black spot below the eye; the lateral spot below the 9-11th scales of the lateral lines, and the tail spot encircled by bright white dots which also appear farther below on the base of the fin. The soft portion of the vertical fins has several diagonal rows of black dots.

"Color in life: upper half dark greenish-brown becoming blue-gray below and violet toward the throat; sides of the head dark gray-brown, yellow-brown below; each scale, especially on the lower half of the body, lighter in the center than the ground color; the three lateral spots black and the spots surrounding the tail spot pure white. The spinous dorsal same color as the back; the soft rays and the caudal fin brownish-yellow; the two last as well as the end of the anal fin dark greenish-brown, the pectorals brownish-yellow. The iris dark brown-yellow, lighter below with some brown shading." (Translated from the German of Heckel: *Wiener Museum D. Naturgeschichte Annalen,* 1841, Vol. 2, p. 342).

"Coleur de l'animal conservé dans la liqueur, d'un brun chocolat avec une tache ocellée sur la dos à la base de la nageoire dorsale; le ventre parait avoir eté plus clair et les opercules dóres." The plate figure differs considerably from this description, showing the iris bright yellow, body in general dark greenish-brown with an elongate ocellus on the upper part of the end of the peduncle. (Castelnau, 1855, *Anim. Amer. Sud. Poiss.*, p. 15, pl. VI).

"Brown, with a black spot on the middle of the sides and with a black ocellus edged with whitish superiorly at the root of the caudal fin, the two spots sometimes united by a band; a dark spot below the orbit; a whitish streak between the eye and the nostril." (Günther, 1862, *Cat. Fishes Br. Mus.*, IV, p. 277).

"Color brown, several darker cross shades across the dorsal region; a large, black ocellus on lateral line. No other spots. Fins dusky. Lower lip yellow." (Cope, 1870, *Proc. Amer. Phil. Soc.*, XI, 570).

"Olive, with jointed, unpaired fins yellow. A large black spot before middle of side on lateral line, a vertical shade at base of caudal. As compared with *A. dimeras*, its closest ally, this fish differs in . . . lack of crossbars." The figure shows no markings at all, except lateral spot. (Cope, 1871, *Proc. Acad. Nat. Sci. Phila.*, XXIII, 255, pl. XI, fig. 4).

"Olivâtre avec une tache noire sur le côté et une autre bordée de blanc en haute de l'origine de la caudale; ces taches parfois

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réunies par une ligne foncée. Un point noir sous l'orbite et une ligne clair entre la narine et l'oeil. Nageoires impaires habituellement ponctuées." (Pellegrin, 1903, *Mem. Soc. Zool. France*, XVI, 171).

"Olivaceous, with 5 dark cross-bars, the first crossing the anterior 7 or 8 scales of the lateral line, the second the 9th or 10th, and 3 succeeding scales of the lateral line, below which it bears a thickish blotch; a dark spot below the posterior part of eye; a dark ocellated spot on the upper part of the base of caudal; usually a dark longitudinal band from lateral blotch to caudal spot, sometimes continued forward to the eye; vertical fins dusky, usually spotted." (Regan, 1905, *Ann. Mag. Nat. Hist.*, (7) XV, 332).

"The pond specimens deeply colored. They show faintly the vertical color bands and a lateral line from the eye to the caudal basis. This interrupted by the lateral spot. Color notes made in the field on the Puerto Bermudez specimens, show the dorsal half of the body deep blue, shading to gray ventrally. Ocellated spot on the peduncle, bordered with yellow; irregular blue-black markings on the caudal fin; fins washed with yellow; five or six longitudinal stripes of yellow on the head from the snout to the eye and cheek. In alcohol a longitudinal color band can be seen in many." (Eigenmann & Allen, 1942, *Fishes of Western South America*, p. 392).

Comments on Aquarium Specimens.

This fish is fairly well known to aquarists and we find descriptions such as the following:

"Color changing; upper half green to greenish brown, bluish gray to reddish beneath, throat violet; sides with about six cross-bars, one of which intensified into a spot below the lateral line; sometimes a dark band from eye to an ocellated spot at the base of the upper caudal rays. Vertical fins spotted or barred; dorsal in its spinal part and anal dark greenish brown; soft dorsal and caudal yellowish. The color markings of the body become obscure with age, those of the fins more intense." (Rachow, 1937, *Tropical Aquariafish*, p. 111).

"Color and markings vary greatly with age and the influence of local conditions but usually it is light green to olive brown, often with a golden or brassy tone. The sides are yellow to slate and the belly is light gray with a rose tint. A black horizontal stripe extends from the eyes, through the middle of the sides, to the caudal spot on a yellow field. Three or more, light to dark brown vertical bands run through the eyes and upper section of the body, enhancing the large area behind the eyes and another under the dorsal fin. The anterior parts of the dorsal and anal fins are dark olive and these fins as well as the caudal, are peppered with dark spots and short lines. The body markings of young specimens are quite pronounced. More mature specimens lose the body markings and those in the fins are more pronounced." (Stoye, *Tropical Fish for the Home*, p. 168).

"No one phase seems to give an adequate representation. A slight change in light produces an entirely different effect, and as we all know, the various Cichlids have a tremendous range of color pattern, due to the influences of emotion, temperature and health." (Innes, 1934, *The Aquarium*, II, p. 277).

Comparison of the Eight Descriptions with the Color Phases of a Single Individual.

In these eight selected descriptions, extending from Heckel in 1841 to Eigenmann and Allen, 1942, we have a cross section of pattern and color as observed and recorded by these authors. We find the following relative mention of five elements of the pattern: Lateral ocellus 8 times, caudal ocellus 7, longitudinal stripe 4, vertical bands 3, sub-ocular spot 4 times.

It is interesting to compare this with the seven phases of a single individual in the accompanying plate, figure one of which is diurnal, and all the others nocturnal. Here, the proportion is, lateral ocellus 7, caudal ocellus 3, longitudinal stripe 4, vertical bands 3, and sub-ocular spot 2 times.

Color Description of Plate.

It has been possible to reproduce the accompanying plate only in black and white, so a few notes on the lost colors are necessary. There are seven figures, all drawn from the same living fish within a period of twenty-four hours. This fish was taken from an almost dried-up mud hole at the edge of the jungle at Tenth Kilometer, Caripito, Venezuela, March 21, 1942. Dep't. Tropical Research Cat. No. 30,006; standard length 75 mm.

Figure 1 shows the typical diurnal pattern and coloration. This is dark brown above and turquoise on the ventral surface. The lateral ocellus is very black. There are five or six, greenish-brown, narrow, longitudinal stripes along the body, alternating with equally narrow stripes of grass green. The opercles are densely, the sides of the body more sparsely, dotted with turquoise blue. The belly and abdomen and the first pelvic ray are solid turquoise, and the sides of the head are alternately streaked and dotted with the same color. The fins are brownish, the vertical fins faintly barred and spotted with darker. The edge of the entire dorsal fin is warm orange.

Figures 2 to 7 show various phases of the pattern as observed at night. Brown is the dominant color, the only exceptions being the black of the ocelli, and the turquoise spots, of which traces remain on the cheeks and opercles, and in all cases the blue of the pelvic ray. All other colors of the diurnal phase are absent.

Pattern in Five Preserved Specimens.

Of five other specimens collected in Venezuela, two came from the dried pool at Tenth Kilometer, two from a small muddy creek known as Rio San Pablo, and one from the clear waters of Rio Caripe. In death all are almost identical, although one was killed in alcohol, two leaped out of their aquarium the first night and died slowly, and the fifth was killed after a week in captivity.

All show the heaviest, most relaxed type of pigmentation, closely approximating Figure 5 on the plate. The whole of each fish, however, is much darker, the vertical bands considerably wider and blacker, the lateral ocellus being almost buried in its particular band. As in the fifth pictured phase, there are nine vertical bands, with a consistent branching of the eighth (counting from the caudal). In two fish, the displaced nuchal band is continuous with the rest of the ninth through eye and opercle. The caudal ocellus is indicated only by a narrow vertical mark, which I call band number one. The lateral ocellus is always in the sixth band from the tail. The boundary of the lateral ocellus is clearly marked in all the fish by a circle of turquoise dots. Others can be seen scattered anteriorly over the side of the body, and many on the opercles. No hint of the blue pelvic ray is visible, in any of the preserved fish.

Venezuelan Field Notes.

The only place I could observe this species under natural conditions was in the Rio Caripe before its waters were muddied by floods. In the dried jungle pools and the small San Pablo the fish were invisible until dug up with a spade or brought to the surface in a hand net. In the Caripe they were abundant, living in loose schools in the back water above riffles. As I waded about I could distinguish them from other cichlids by the conspicuous black lateral spot. This seems the only pattern element which is present under all conditions. Several times when fish escaped from the seine and rejoined their free fellows, they became at once indistinguishable, having undergone no apparent pattern changes as a result of fear or excitement.

A number of specimens were kept in a small air-supplied aquarium in the laboratory, past which several of us walked many times a day. These showed almost no change during the hours of daylight, and even when excited by the sudden appearance of food, the lateral spot was the only dominant mark.

Pattern Change in a Single Individual.

As already mentioned, Figure 1 shows the typical diurnal pattern, as observed in undisturbed and disturbed fish in their normal haunts and in the aquarium. At night, whether in the dimmest light, or in the illumination from a powerful flashlight, the pattern came and went in bewildering combinations of the four shifting pattern elements, caudal ocellus, longitudinal stripe, vertical bands, sub-ocular spot, in intricate changes around the permanent lateral ocellus.

Extremes are shown by Figures 2 and 5. In the former, the fish for the most part is white, shading into pale brown on head and back. Figure 6 shows the two ocelli and the eye all connected by a longitudinal stripe. Figure 3 has the sub-ocular spot, and a slight discontinuity of the stripe. In Figure 7 the stripe ends at the lateral ocellus, the posterior half and the caudal ocellus having vanished. Three vertical half bands are present on the postero-inferior quarter of the body. Figure 4 has vertical bands 1, 2, 3, 4, 5 and 7 developed (counting from the caudal), with bands 6, 8 and 9, and the posterior half of the longitudinal stripe lacking. Figure 5 is a pale phase of what persists in all preserved specimens, the most intense amount of pigmentation, lacking only the narrow longitudinal stripes of the diurnal pattern and the caudal ocellus. In this phase even the iris of the eye changes its pigmentation to emphasize and complete the ninth band on the lower part of the head.

Pattern of Other Living Individuals.

Another individual fish of the same species which I examined six times in one night, showed phases approximating Figures 4, 5 and 7, with the vertical bands always in evidence, greatly diminished in only one case. A third fish at 11 P.M. and 2 and 3 A.M. showed no trace either of caudal ocellus or longitudinal stripe.

This brief treatment is meant only to stimulate, and to emphasize the value of future observation in the field, both by day and night. The nocturnal changes in pattern and color, as I have often observed in tide-pool fish[2] are something to be reckoned with in our descriptions both of well known and of newly discovered species, and in explanation of ecological adaption. In the present instance I had no opportunity to obtain detailed data on specific causes, whether psychological, sensory or environmental, of

[2] *Book of Bays*, page 169.

these changes, but if our keys and careful descriptions dealing with pattern and color of species and sub-species are to withstand both laboratory, aquarium and field scrutiny, individual changes must be taken into account, and reduced to correct values in diagnoses.

As one last example, Eigenmann, in the description of a new species, writes[3] *Aequidens potaroënsis* is "evidently very closely related to *A. tetramerus* from which it can easily be distinguished by the dark band from the eye through the angle of the opercle." On this diagnosis alone it appears in the plate as Figure 5, at least on one night, when it became and quite departed from the said species within a period of ten minutes.

My sincere thanks go to Miss Francesca LaMonte for graciously given assistance.

[3] Eigenmann, *Fishes of British Guiana*, 1912, p. 490.

EXPLANATION OF THE PLATE.

Plate I.

The Venezuelan Cichlid fish, *Aequidens tetramerus*. Seven pattern and color phases of a single individual fish, within twenty-four hours time. Figure 1 is the diurnal pattern, all others nocturnal. From a painting by George Swanson.